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Terrestrial gastropods of Reserva Florestal Humaitá, southwestern Brazilian Amazon

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Abstract

The molluscan fauna of southwestern Brazilian Amazon is poorly known due to the lack of focused collection efforts in the region since the early 20th century. The present study provides an inventory of the terrestrial gastropods from a forest fragment in the eastern Acre state, Brazil: the Reserva Florestal Humaitá. Live specimens and empty shells were collected between August 2018 and January 2019. A total of 20 species were identified, comprising 11 families. Most (12) of these species were recorded in Acre for the first time. Furthermore, we confirm the occurrence of *Systrophia helicycloides* (d'Orbigny, 1835) in Brazil, reiterate the synonymy of *Plekocheilus pentadinus* (d'Orbigny, 1835) with *P. floccosus* (Spix *in* Wagner, 1827), and synonymize *Solaropsis peruviana* Haas, 1951 with *S. juruana* Ihering, 1905.

Keywords

Acre, Ampullarioidea, DNA barcoding, Gastropoda, Neritimorpha, Stylommatophora

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Introduction

The Amazon rainforest has the richest biodiversity of any of the world's biomes (Mittermeier et al. 2003); although some groups of organisms, such as plants (e.g., Ter Steege and Rainford 2009) and vertebrates (e.g., Mittermeier et al. 2003), are relatively well known, the diversity of terrestrial mollusks of that region remains poorly understood. In fact, only 15% of the land snails known to occur in Brazil have been recorded from the Amazon region (Salvador 2019). This paucity of data reflects the general lack of studies on this group in Brazil, and the greatly reduced sampling effort in the Amazon basin overall, especially considering its enormous area. The scarce malacological research in the region has resulted in new records of species for Brazil (Salvador et al. 2020a, 2020b) and even the discovery of new species (Simone 2010; Jardim et al. 2013) in the past decade.

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Undersampled as the Amazon is for land and freshwater gastropods, the situation is even more dire in southwestern Amazon, which includes the Brazilian state of Acre (Salvador 2019). Paraense (1967, 1981, 1983) recorded planorbids in the region for the first time, while Salvador et al. (2020b) recorded *Helicina chionea* Pilsbry, 1949 in Brazil for the first time, as well as two new records of *Helicina* spp. Lima and Guilherme (2018) also recently reported the infestation of the urban zone of the state capital, Rio Branco, by the exotic land snail *Lissachatina fulica* (Bowdich, 1822). Given the paucity of data from that region, the present study aimed to compile an inventory of the terrestrial gastropods found in a forest reserve in eastern Acre, the Reserva Florestal Humaitá (Humaitá Forest Reserve, henceforth HFR).

Study Area

The HFR, managed by the Federal University of Acre, has a total area of 2,000 ha and is located approximately 30 km northwest of the state capital Rio Branco; it belongs to the municipality of Porto Acre (HFR entrance coordinates: 09°45′01.9″S, 067°40′18.8″W; Fig. 1). Local topography is a gentle slope traversed by narrow but deep streams, which flood the lowest portions of HFR during the rainy season (December to April). Mean annual precipitation in the area is 2000–2100 mm, with rains peaking between January and March; the driest period is June to August (Governo do Estado do Acre 2010). The predominant vegetation is open lowland Amazonian *terra firme* rainforest (Fig. 2A–D) (Governo do Estado do Acre 2010).

Methods

Collection and identification. The specimens were collected between August 2018 and January 2019, with a total of 272 field hours expended over 17 days by two collectors. Both live specimens and empty shells were collected by random active searches; no examination of leaf litter or soil samples was conducted. The specimens were processed in the Laboratory of Malacology of Federal University of Acre (UFAC) in Rio Branco; live specimens were euthanized, fixed and preserved in ethanol 70%. The specimens were deposited partially in the collection of UFAC and partially in the Museum of Zoology of the University of São Paulo (MZSP, São Paulo, Brazil). The full list of voucher material can be found under each species entry below. Abbreviations: leg.: collector; H: shell height.

Specimens were identified based on specialized taxonomic literature (e.g., Simone 2006) and comparisons with type material (or photographs thereof) and other voucher specimens from the MZSP. The checklist of species from HFR is presented below, arranged following the classification of Bouchet et al. (2017).

DNA extraction and sequencing. In an ongoing effort to produce a genetic library of neotropical snails, selected specimens had a fraction of their foot removed for DNA extraction. For some species, there were no specimens

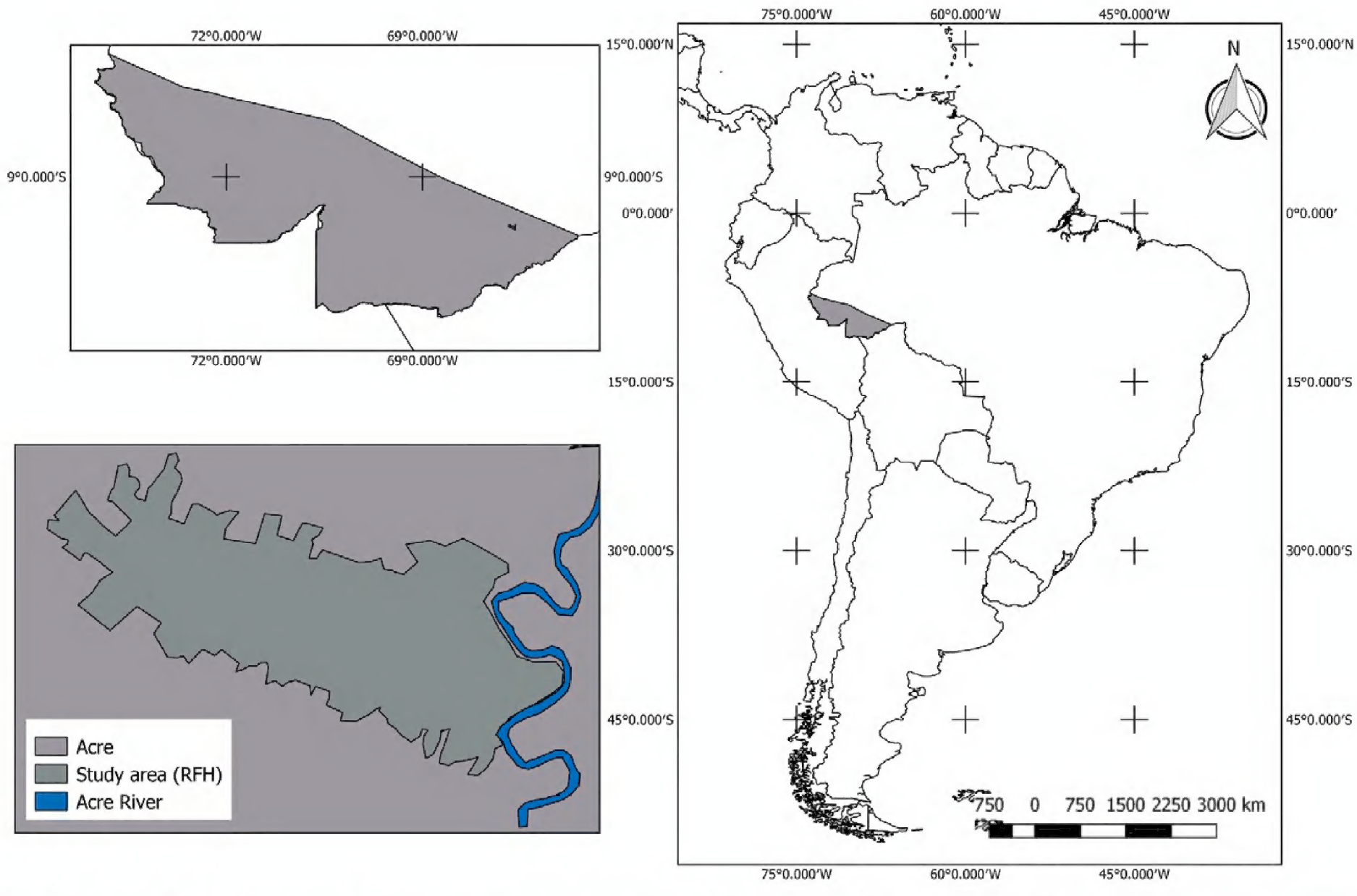

Figure 1. Map showing Acre state in Brazil, with inset showing the location of Reserva Florestal Humaitá (HFR) in Acre, and inset showing the area of the reserve.

Figure 2. Collection location. **A.** Acre River. **B–D.** Typical vegetation with predominance of bamboo.

with preserved soft tissue from the HFR. In those cases, we used representatives of the same species collected in nearby localities (outside the HFR); all specimens were adults to guarantee a precise identification. DNA extraction was done using the QIAGEN DNeasy® Blood & Tissue Kit, following standard protocols.

We targeted four markers commonly used in phylogenetic studies of stylommatophoran snails: 1) The barcoding fragment of the mitochondrial CO1 gene (cytochrome c oxidase subunit I; ~650 bp), using primers LCO and HCO of Folmer et al. (1994). 2) The mitochondrial 16S rRNA gene (c. 450 bp), using primers 16SarL and 16SbrH of Simon et al. (1994). 3) A fragment of nuclear DNA encompassing the 3′ end of the 5.8S rRNA gene, the ITS2 (internal transcribed spacer 2) region, and the 5′ end of the 28S rRNA gene (c. 1,300 bp), amplified in two fragments using primers LSU-1/LSU-3 and LSU-2/LSU-5 (Wade and Mordan 2000; Wade et al. 2006). 4) A fragment of histone 3 (H3) gene, using primers H3pulF and H3pul3 from Uit de Weerd and Gittenberger (2013).

PCR amplification for CO1 and 16S consisted of: initial denaturation at 96 °C (2 min); 35 cycles of denaturation at 94 °C (30 s), annealing at 48 °C (1 min) and extension at 72 °C (2 min); final extension at 72 °C (5 min). PCR protocol for ITS2+28S consisted of: initial denaturation at 95 °C (3 min); 40 cycles of denaturation at 95 °C (30 s), annealing at either 50 °C (ITS2 section) or 45 °C (28S section) (1 min) and extension at 72 °C (2 min); final extension at 72 °C (4 min). PCR protocol for H3 consisted of: initial denaturation at 96 °C (3 min); 40 cycles of denaturation at 94 °C (30 s), annealing at 57 °C (30 s) and extension at 72 °C (40 s); final extension at 72 °C (4 min). PCR products were quantified via agarose gel electrophoresis, cleaned and Sanger sequenced. Sequences were assembled, quality-assessed, and trimmed in Geneious Prime (v. 2019.0.3, Biomatters Ltd.). Consensus sequences were uploaded to GenBank; see each species entries for registration numbers.

Results

A total of 51 specimens were collected during the present study, representing 20 species in 11 families (Table 1). Despite the focus on terrestrial gastropods, a single freshwater species was collected and is listed below. The most diverse families were the Achatinidae (Subulininae), with five species, and the Scolodontidae, with four

species. In three cases, it was only possible to identify the taxon to genus level, given they were represented by juvenile and/or poorly-preserved specimens only.

Neritimorpha
Superfamily Helicinoidea
Family Helicinidae
Genus *Helicina* Lamarck, 1799

Helicina chionea Pilsbry, 1949

Figure 3A–F

Helicina chionea Pilsbry 1949: 101.

Material examined. Brazil; **Acre** • Porto Acre, HFR; 09°45′05″S, 067°40′22″W; 16.XII.2018; M. Lima and W. Lima leg.; 1, MZSP 150066 (ex UFAC 1036) • same locality; 09°45′01″S, 067°40′22″W; 10.I.2019; W. Lima and L. Guimarães leg.; 1, MZSP 150067 (ex UFAC 1061) • same locality; 09°45′09″S, 067°38′23″W; 14.XII.2018; 1, L. Freitas leg.; UFAC 1032.

Identification. The species can be identified by its whitish and partially translucent shell, with inconspicuous white spiral streaks on the teleoconch (Pilsbry 1949). Known from Peru, the only record of the species in Brazil is from HFR (Salvador et al. 2020b).

Type locality. Mejorada, near Huancayo, Peru.

Distribution. From Huancayo, Peru, to eastern Acre, Brazil (Salvador et al. 2020b).

Helicina juruana Ihering, 1905

Figure 3G–K

Helicina carinata juruana Ihering 1905: 458.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′13″S, 067°40′09″W; 12.X.2018; M. Lima and W. Lima leg.; 1, MZSP 150063 (ex UFAC 996) • same locality; 09°45′04″S, 067°40′15″W; 09.I.2019; W. Lima and L. Guimarães leg.; 1, MZSP 150064 (ex UFAC 1048) • same locality; no coordinates recorded; 12.I.2017; 2, UFAC 717.

Identification. The species is diagnosed by the ochre/brownish coloration of the shell, pronounced keel on the body whorl, and angular aperture (Ihering 1905). It was reported for the first time from Acre by Salvador et al. (2020b).

Type locality. The Juruá River, Amazonas state, Brazil.

Distribution. From western Amazonas state to eastern Acre, Brazil (Salvador et al. 2020b).

Table 1. Terrestrial and freshwater gastropod species recorded in the Reserva Florestal Humaitá (HFR), in the municipality of Porto Acre, Acre state, Brazil.

Family	Species	No. specimens	First record in Acre
Helicinidae	*Helicina chionea* Pilsbry, 1949	3	
	Helicina juruana Ihering, 1905	4	
	Helicina laterculus F.C. Baker, 1913	1	
Ampullariidae	*Pomacea* sp.	3	
Achatinidae	*Beckianum beckianum* (Pfeiffer, 1846)	5	X
	Leptinaria unilamellata (d'Orbigny, 1838)	1	X
	Obeliscus sp.	2	
	Stenogyra sp.	2	
	Subulina octona (Bruguière, 1789)	2	
Scolodontidae	*Happia snethlagei* F.C. Baker, 1913	5	X
	Happia sp.	2	
	Systrophia helicycloides (d'Orbigny, 1835)	2	X
	Entondina jekylli F.C. Baker, 1913	4	X
Orthalicidae	*Corona regalis* (Hupé, 1857)	2	X
Amphibulimidae	*Plekocheilus floccosus* (Spix *in* Wagner, 1827)	1	X
Bulimulidae	*Drymaeus expansus* (L. Pfeiffer, 1848)	2	X
Spiraxidae	*Euglandina striata* (O.F. Müller, 1774)	1	X
Euconulidae	*Habroconus mayi* (F.C. Baker, 1913)	2	X
Solaropsidae	*Solaropsis juruana* Ihering, 1905	4	X
Labyrinthidae	*Labyrinthus diminutus* (Gude, 1903)	3	X

Helicina laterculus F.C. Baker, 1913

Figure 3L–N

Helicina laterculus Baker 1913: 626.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′40″S, 67°38′33″ W; 07.IX.2018; M. Lima leg.; 1, UFAC 989.

Identification. The species is identifiable by its small, round, and smooth shell of reddish-brown translucent color, and its semicircular aperture (Baker 1913). It was reported for the first time from Acre by Salvador et al. (2020b).

Type locality. Pará state, Brazil.

Distribution. From Pará state to eastern Acre, Brazil (Salvador et al. 2020b).

Caenogastropoda
Superfamily Ampullarioidea
Family Ampullariidae
Genus *Pomacea* Perry, 1810

Pomacea sp.

Figure 3O, P

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′07″S, 067°40′17″W; 01.XII.2018; M. Lima leg.; 2, MZSP 150092 (ex UFAC 1020) • same locality; 09°45′29″S, 067°39′13″W; 29.VIII.2018; M. Lima leg.; 1, UFAC 925.

Identification. The specimens are juvenile and, thus, difficult to identify to species level. The yellowish-ochre shell with light brown spiral bands, along with the taller-than-wide elliptical aperture are reminiscent of published figures of *P. levior* (G.B. Sowerby III, 1909), known from the Amazon River in Amazonas and Pará states, Brazil (Simone 2006). The genus has a convoluted taxonomy, however, and *P. levior* in particular is considered a *taxon inquirendum* (MolluscaBase 2020).

Eupulmonata
Stylommatophora
Superfamily Achatinoidea
Family Achatinidae
Genus *Beckianum* H.B. Baker, 1961

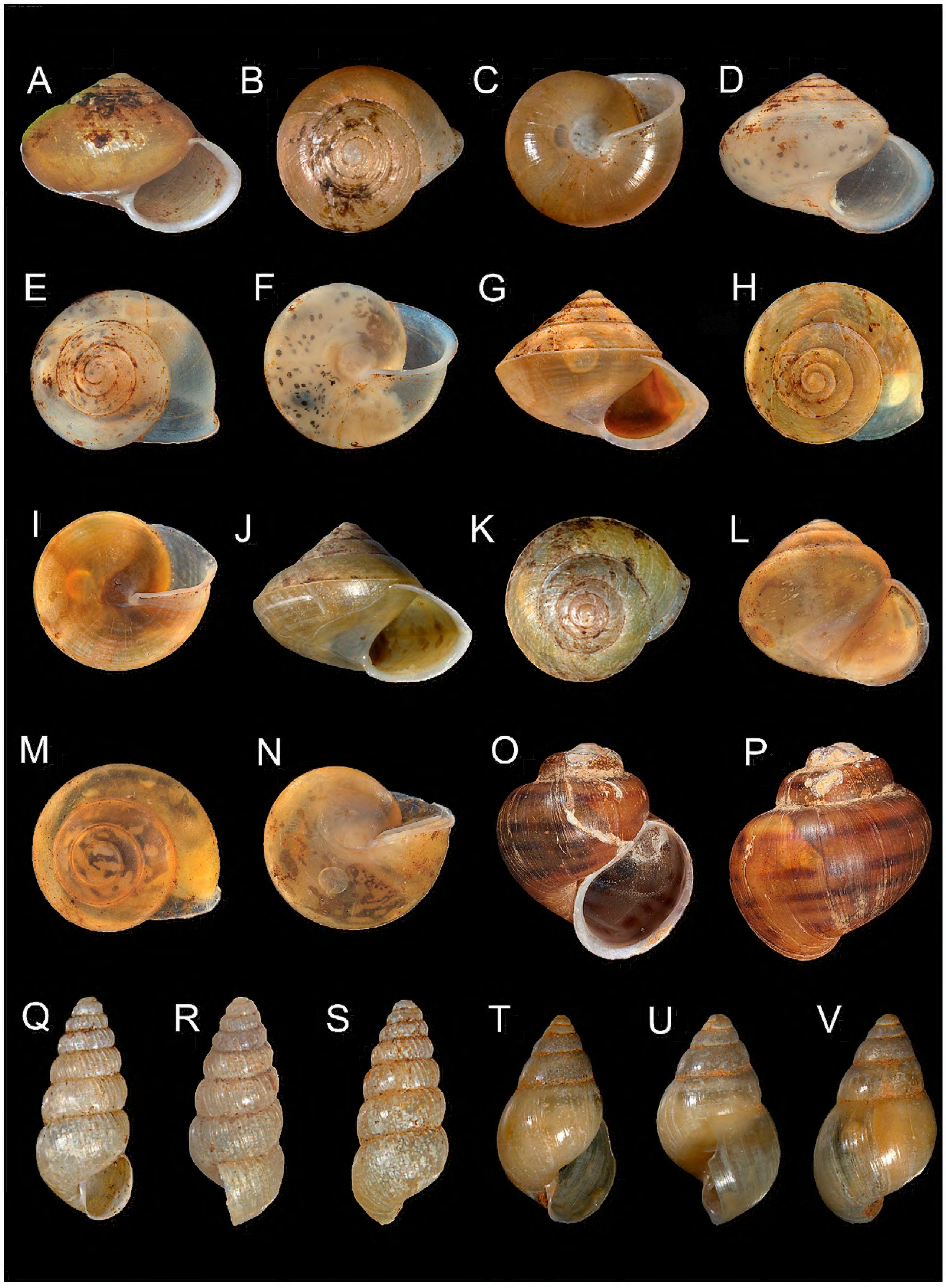

Figure 3. Shells from Acre state. **A–C.** *Helicina chionea*, MZSP 150066 (H = 5.4 mm). **D–F.** *Helicina chionea*, UFAC 1032 (H = 5.6 mm). **G–I.** *Helicina juruana*, UFAC 717 (H = 7.3 mm). **J, K.** Helicina juruana, MZSP 150063 (H= 7.5 mm). **L–N.** *Helicina laterculus,* UFAC 989 (H = 4.2 mm). **O, P.** *Pomacea* sp., UFAC 925 (H = 17.0 mm). **Q–S.** *Beckianum beckianum*, UFAC 971 (H = 5.9 mm). **T–V.** *Leptinaria unilamellata*, UFAC 1039 (H = 11.3 mm).

***Beckianum beckianum* (L. Pfeiffer, 1846)**
Figure 3Q–S

Bulimus beckianus L. Pfeiffer 1846: 82.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′12″S, 067°40′09″W; 23.IX. 2018; M. Lima and W. Lima leg.; 5, UFAC 971.

Identification. This is the first specific record of *B. beckianum* from Acre. Despite being within the species' expected distribution (it is common in Latin America), the present record is actually an extension of the species' known distribution within Brazil, given that its closest known record was previously from Pará state (Birckolz et al. 2016).

Type locality. Opara Island, Polynesia (Pfeiffer 1846). Pilsbry (1906) considered this locality mistaken, arguing that Pfeiffer's specimens were most similar to those from Central America (Salvador and Simone 2015; Silva et al. 2019).

Distribution. Mexico to Brazil (Pará to São Paulo, Fernando de Noronha), including the Caribbean Islands (Simone 2006; Birckolz et al. 2016). It has been introduced to Hawaii and to greenhouses in Europe (Cowie 1997; Horsák et al. 2020).

Genus *Leptinaria* Beck, 1837

***Leptinaria unilamellata* (d'Orbigny, 1838)**
Figure 3T–V

Helix unilamellata d'Orbigny 1835: 9 [*nomen nudum*].
[*Achatina lamellata*] Potiez and Michaud 1835: pl. 11, figs. 7, 8 [figure only, no name].
Bulimus unilamellata d'Orbigny 1838: 257.
Achatina lamellata Potiez and Michaud 1838: 128.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′04″S, 067°40′23″W; 16.XII.2018; W. Lima and M. Lima leg.; 1, UFAC 1039.

Type locality. Undefined; nevertheless, Delannoye et al. (2015) listed Santa Cruz, Bolivia, as the possible type locality.

Distribution. Nicaragua to Brazil (Simone 2006; Delannoye et al. 2015). It has been introduced to French Polynesia and identified as a greenhouse species in Europe (Soubeyran 2008; Proschwitz 2017).

Remarks. The confusing taxonomy of this species and the dispute between the names *L. unilamellata* (d'Orbigny, 1838) and *L. lamellata* (Potiez & Michaud, 1838) has just been resolved by Breure et al. (2020).

Genus *Obeliscus* Beck, 1837

***Obeliscus* sp.**
Figure 4A, B

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′42″S, 067°38′31″W; 07.IX.2018; M. Lima and W. Lima leg.; 1, UFAC 956 • same locality; 09°45′01″S, 067°40′19″W; 10.I.2019; W. Lima and L. Guimarães leg.; 1, UFAC 1052.

Identification. The present specimens are juvenile and cannot be reliably identified to species level. There are eight species of *Obeliscus* presently reported from Brazil (Simone 2006; Birckolz et al. 2016), none of which has been specifically reported from Acre.

Genus *Stenogyra* Shuttleworth, 1854

***Stenogyra* sp.**
Figure 4C–E

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′12″S, 067°40′09″W; 23.IX.2018; M. Lima and W. Lima leg.; 2, UFAC 973.

Identification. The present specimens are juvenile and not well preserved, making identification to species level difficult. Nevertheless, the whitish coloration of the shell indicates that the present specimens could belong to *S. octogyra* (L. Pfeiffer, 1856), the most widespread *Stenogyra* species in South America (Simone 2006).

Genus *Subulina* Beck, 1837

***Subulina octona* (Bruguière, 1789)**
Figure 4F–H

Bulimus octonus Bruguière, 1789: 325.

Material examined. Brazil • Acre, Porto Acre, HFR; 09° 45′01″S, 067°40′19″W; 10.I.2019; W. Lima and M. Lima leg.; 2, UFAC 1052.

Type locality. Guadeloupe.

Distribution. Naturally occurring in tropical continental Americas, but introduced to the Caribbean Islands, Africa, Asia, and Pacific Islands (Pilsbry 1906; Cowie 2000; Massemin et al. 2009; Miquel and Herrera 2014).

Superfamily Scolodontoidea
Family Scolodontidae
Genus *Happia* Bourguignat, 1889

***Happia snethlagei* F.C. Baker, 1913**
Figure 4I–K

Happia snethlagei Baker 1913: 629, pl. 22, figs. 3, 4.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09° 45′40″S, 067°38′34″W; 07.IX.2018; M. Lima and W. Lima leg.; 1, MZSP 150038 (ex UFAC 978) • same locality; 09°44′48″S, 067°39′40″W; 09.I.2019; W. Lima and L. Guimarães leg.; 1, MZSP 150039 (ex UFAC 1044) • same locality; 09°45′27″S, 067°39′35″W; 29.VIII. 2018; M. Lima and W. Lima leg.; 1, MZSP 150041 (ex UFAC 937) • same locality; 09°44′49″S, 067°39′29″W; 09.I. 2019; W. Lima and L. Guimarães leg.; 1, MZSP 150043 (ex UFAC 1045) • same locality; 09°45′35″S, 067°39′03″W; 30.VIII.2018; M. Lima and W. Lima leg.; 1, MZSP 150045 (ex UFAC 942).

Identification. The flattened shell, with a low but still visible spire, and small round aperture allow the identification of the present specimens. The present record from eastern Acre extends the species distribution circa 250 km to the west.

Type locality. Porto Velho, Rondônia state; and Camps 39, 40 and 46 (respectively, 284 km, 292 km and 359 km

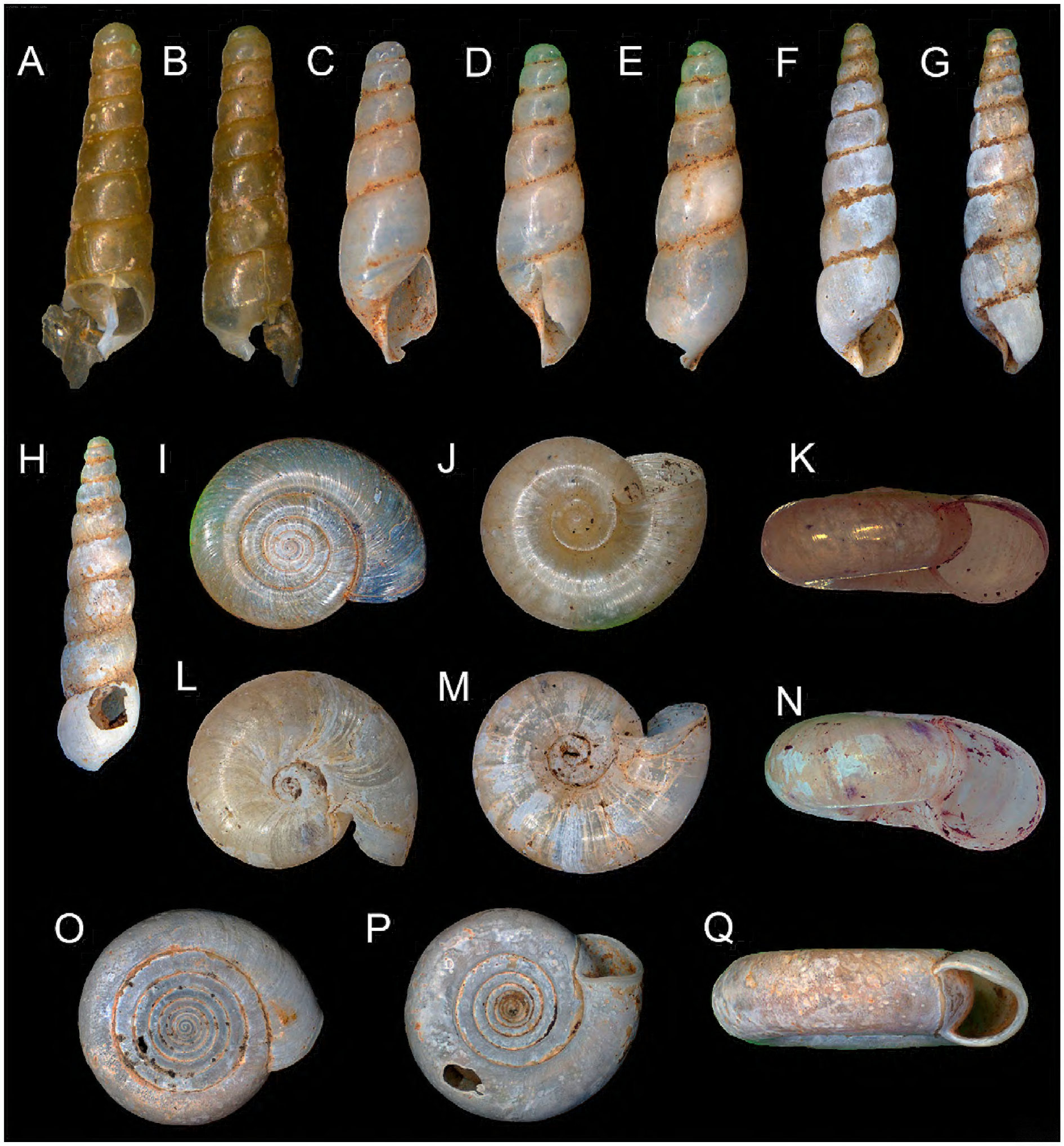

Figure 4. Shells from Acre state. **A, B.** *Obeliscus* sp., UFAC 956 (H = 7.9 mm). **C–E.** *Stenogyra* sp., UFAC 973 (H = 7.4 mm). **F–H.** *Subulina octona*, UFAC 1052 (H = 17.2 mm). **I–K.** *Happia snethlagei*, MZSP 150041 (H = 14.2 mm). **L–N.** *Happia* sp., MZSP 150056 (H = 5.6 mm). **O–Q.** *Systrophia helicycloides*, MZSP 150060 (H = 11.6 mm).

above Porto Velho along Madeira–Mamoré Railroad), Rondônia state, Brazil. Restricted to Camp 39 through lectotype designation (F. Borrero pers. comm.).

Distribution. From eastern Amazonas state to northern Rondônia state (Simone 2006).

***Happia* sp.**

Figure 4L–N

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′32″S, 067°39′05″W; 30.VIII.2018; M. Lima and W. Lima leg.; 1, MZSP 150055 (ex UFAC 946) • same locality; 09°45′09″S, 067°40′22″W; 14.XII. 2018; L. Freitas leg.; 1, MZSP 150056 (ex UFAC 1033).

Identification. The present specimens present a set of conchological characters not seen, to our knowledge, in any other Brazilian or Peruvian *Happia* spp., namely: whorls growing rapidly in size and coiled closely packed together; a tall round body whorl; a large elliptical aperture, positioned diagonally in relation to the columellar axis of shell. A few species (Simone 2006) present each of those characters at a time, but not all at once. Given that conchological characters are typically insufficient for classification of *Happia* and related genera, we prefer to leave the identification of the present specimens open until molecular-grade material is available and the genus is revised.

Genus *Systrophia* Pfeiffer, 1855

***Systrophia helicycloides* (d'Orbigny, 1835)**
Figure 4O–Q

Helix helicycloides d'Orbigny 1835: 6.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°44′49″S, 067°39′29″W; 09.I.2019; W. Lima and L. Guimarães leg.; 2, MZSP 150060 (ex UFAC 1046).

Identification. This species is diagnosable by the lightly expanded final third of the body whorl, the small and simple D-shaped aperture lacking any teeth or other armature. This species was erroneously listed from Amazonas state in Brazil by Simone (2006); the locality indicated by that author, the Chaparé River, is in Bolivia. As such, the present record from Acre is the first actual record of *S. helicycloides* in Brazil.

Type locality. Bolivia.

Distribution. Colombia to Bolivia (Ramírez et al. 2012).

Genus *Entodina* Ancey, 1887

***Entodina jekylli* F.C. Baker, 1913**
Figure 5A–C

Entodina jekylli Baker 1913: 630, pl. 22, figs. 11–13.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′04″S, 067°40′23″W; 16.XII.2018; W. Lima and L. Lima leg.; 1, MZSP 150077 (ex UFAC 1038) • same locality; 09°45′13″S, 067°40′09″W; 12.X.2018; M. Lima and W. Lima leg.; 1, MZSP 150079 (ex UFAC 999) • same locality; 09°45′06″S, 067°40′14″W; 12.X.2018; M. Lima and W. Lima leg.; 1, MZSP 150084 (ex UFAC 974) • same locality; 09°45′07″S, 067°40′14″W; 01.XII.2018; M. Lima leg.; 1, UFAC 1023.

Identification. This species is diagnosed by the faint angulation on the peripheral section of body whorl, the angulation on the base of the body whorl surrounding the umbilicus, the lightly raised spire, and the comparatively weak apertural armature. This record is the first from Acre and extends the species distribution circa 250 km to the west.

Type locality. Camp 39, 284 km above Porto Velho (Rondônia state) along Madeira–Mamoré Railroad, Brazil.

Distribution. From northern Rondônia state to northeastern Goiás state, Brazil (Salvador et al. 2017). Previous records from Peru and Bolivia do not represent this species (see Salvador et al. 2017).

Superfamily Orthalicoidea
Family Orthalicidae
Genus *Corona* Albers, 1850

***Corona regalis* (Hupé, 1857)**
Figure 5D–F

Bulimus regalis Hupé 1857: 34, pl. 10, fig. 3.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′03″S, 067°40′20″W; 10.I.2019; W. Lima and L. Guimarães leg.; 1, MZSP 150030 (ex UFAC 1063) • same locality; 09°45′45″S, 067°38′31″W; 07.IX.2018; M. Lima and W. Lima leg.; 1, MZSP 150086 (ex UFAC 953).

Identification. The species is identifiable by its conical spire with straight whorl profile, a narrow, dashed, yellow-and-black spiral band immediately above the suture, and the black columella. Even though the present specimens are both sinistral, specimens collected elsewhere in Acre present both sinistral and dextral shells (UFAC 620, UFAC 853, from Rio Branco and Senador Guiomard municipalities, respectively). As argued by Breure and Mogollón Avila (2016), *C. regalis* is morphologically very close to *C. regina* (A. Férussac, 1823), which is distributed throughout northern South America (Simone 2006) and might be synonymous with it. The present record, although the first specifically from Acre, is well within the species expected distribution.

Genetic data. CO1, MW033969; 16S, MW035045; ITS2+28S, MW035049; H3, MW147744; from voucher specimen UFAC 853 (Acre, Senador Guiomard, Fazenda Experimetal Catuába, 10°03′60″S, 067°36′24″W; M.S. Lima leg., 11.I.2010).

Type locality. Brazil.

Distribution. Colombia, Ecuador, Peru, and Amazonas and Rondônia states in Brazil (Simone 2006; Breure and Mogollón Avila 2016).

Family Amphibulimidae
Genus *Plekocheilus* Guilding, 1823

***Plekocheilus floccosus* (Spix *in* Wagner, 1827)**
Figure 5G–I

Achatina floccosa Spix *in* Wagner 1827: pl. 9, figs. 3, 4.
Helix pentadina d'Orbigny 1835: 8.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′03″S, 067°40′22″W; 02.XII.2018; V. Souza leg.; 1, UFAC 1030.

Identification. Simone (2006) considered *P. pentadinus* d'Orbigny, 1835 as a separate species, but it has long been considered a synonym of *P. floccosus* (Weyrauch 1967; Breure and Mogollón Avila 2016). As such, the locality Guajará-Açu, a waterfall in Rondônia state, reported by Simone (2006) should be added to the other geographic distribution of *P. floccosus* in Brazil. Given the overall distribution of this species, its occurrence in Acre was completely expected.

Type locality. Forests in southern part of the North Region of Brazil.

Distribution. Ecuador, Peru, Bolivia, and Amazonas and Rondônia states in Brazil (Breure and Mogollón Avila 2016).

Family Bulimulidae
Genus *Drymaeus* Albers, 1850

***Drymaeus expansus* (L. Pfeiffer, 1848)**
Figure 5J–L

Bulimus expansus Pfeiffer 1848: 60.

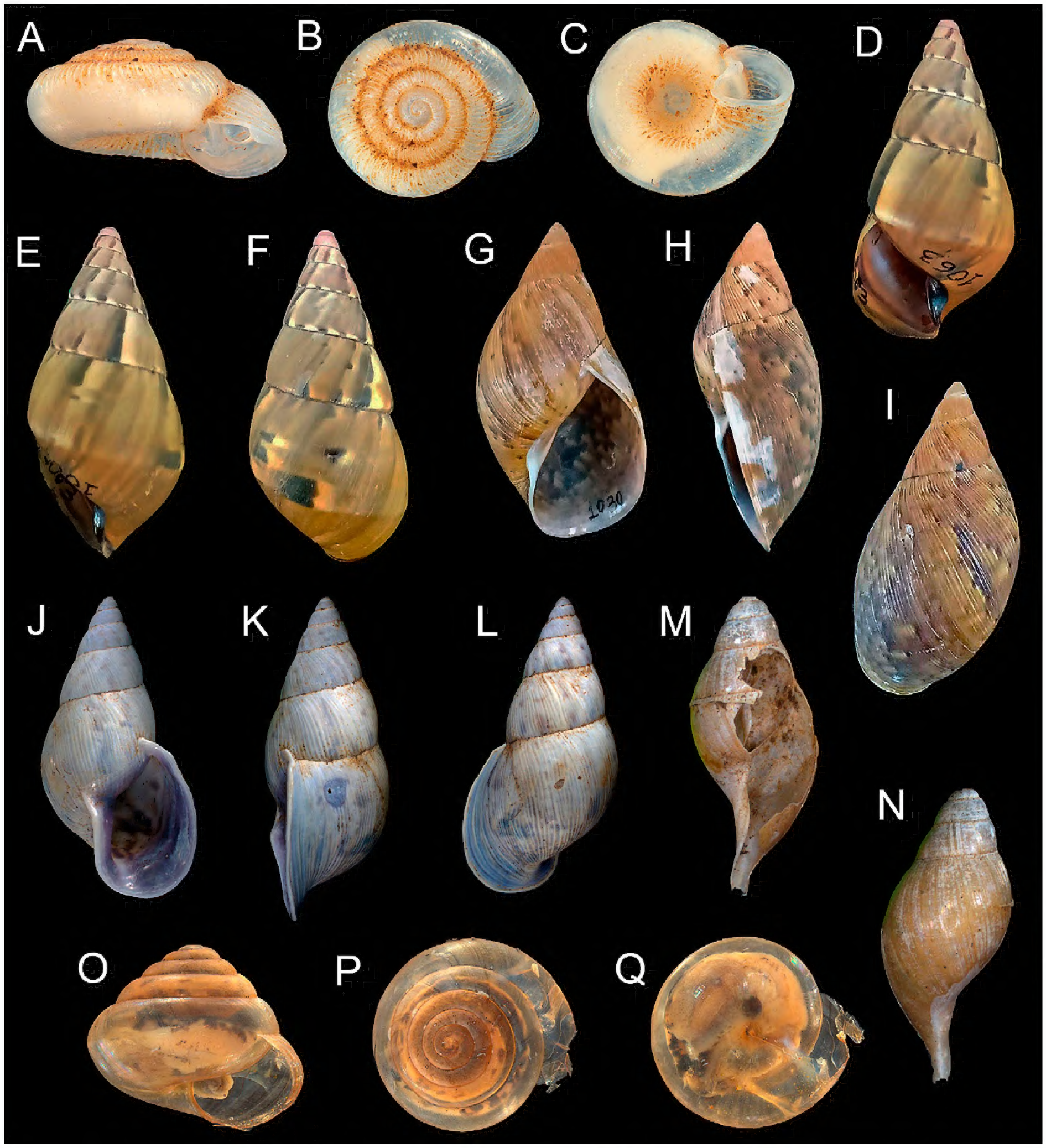

Figure 5. Shells from Acre state. **A–C.** *Entondina jekylli*, UFAC 1023 (H = 1.3 mm). **D–F.** *Corona regalis*, MZSP 150030 (H = 60.8 mm). **G–I.** *Plekocheilus floccosus*, UFAC 1030 (H = 72.9 mm). **J–L.** *Drymaeus expansus*, MZSP 150034 (H = 33.6 mm). **M–N.** *Euglandina striata*, MZSP 150089 (H = 19.4 mm). **O–Q.** *Habroconus mayi*, UFAC 715 (H = 3.8 mm).

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′13″S, 067°40′09″W; 12.X.2018; M. Lima and W. Lima leg.; 1, MZSP 150033 (ex UFAC 994) • same locality; 09°45′12″S, 067°40′09″W; 23.IX.2018; M. Lima and W. Lima leg.; 1, MZSP 150034 (ex UFAC 967).

Identification. This species is characterized mainly by the coarse axial lines on the teleoconch and the reflected peristome which is dark purple on the inside of the shell. The present record extends the species distribution to Acre state.

Type locality. Huallaga, Peru.

Distribution. Panama, Colombia, Ecuador, Peru, and the Brazilian states of Amazonas and Rondônia (Simone 2006; Breure and Borrero 2008, 2019).

Superfamily Oleacinoidea
Family Spiraxidae
Genus *Euglandina* Crosse & P. Fischer, 1870

***Euglandina striata* (O.F. Müller, 1774)**
Figure 5M, N

Buccinum striatum Müller 1774: 149.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′33″S, 067°39′02″W; 30.VIII.2018; M. Lima and W.

Lima leg.; 1, MZSP 150089 (ex UFAC 941).

Identification. The present specimen is a deteriorated shell, but it is identifiable as *E. striata*, a common species in northern South America.

Type locality. Unknown.

Distribution. Panama to northern Brazil (Amazonas and Rondônia states) (Pilsbry 1930; Jardim et al. 2013; Murgas et al. 2020).

Superfamily Trochomorphoidea
Family Euconulidae
Genus *Habroconus* Crosse & P. Fischer, 1872

***Habroconus mayi* (F.C. Baker, 1913)**
Figure 5O–Q

Guppya mayi Baker 1913: 632, pl. 21, figs. 6, 7.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′54″S, 067°68′34″W; 12.I.2017; M. Lima leg.; 2, UFAC 715.

Identification. The present specimens were collected in 2017, on a trip previous to the actual main collection effort. They can be identified by their delicate, brown, translucent, conical shell, which lacks a strong angulation on the body whorl (Baker 1913). This record, the first from Acre, extends the species distribution circa 250 km to the west.

Genetic data. CO1, MW033970; 16S, MW035046; ITS2+28S, MW045521; from voucher specimen UFAC 715.

Type locality. Camp 39, 284 km above Porto Velho (Rondônia state) along Madeira-Mamoré Railroad, Brazil.

Distribution. Northern Rondônia state and possibly southern Amazonas state, Brazil (Simone 2006).

Superfamily Sagdoidea
Family Solaropsidae
Genus *Solaropsis* Beck, 1837

***Solaropsis juruana* Ihering, 1905**
Figure 6A–I

Solaropsis rugifera juruana Ihering 1905: 456.

Solaropsis (*Psadara*) *monile peruviana* Haas 1951: 528, fig. 114. [new synonym]

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′21″S, 067°40′06″W; 12.X.2018; M. Lima and W. Lima leg.; 1, MZSP 150068 (ex UFAC 1006) • same locality; 09°45′03″S, 067°40′21″W; 10.I.2019; W. Lima and L. Guimarães leg.; 1, MZSP 150069 (ex UFAC 1058) • same locality; 09°45′37″S, 067°38′51″’W; 07.IX.2018; M. Lima and W. Lima leg.; 1, UFAC 986 • same locality; 09°45′03″S, 067°40′20″W; 23.VIII.2018; W. Castro leg.; 1, UFAC 1064.

Identification. The flattened spire, compact overall shape, round and proportionately large aperture, and coloration pattern with two dark, dashed, spiral lines, compare well with *S. juruana* (syntypes MZSP 1364; Fig. 6D–F). We stress that *S. monile peruviana* Haas, 1951 (holotype FMNH 30928, Field Museum of Natural History, Chicago, USA; Fig. 6G–I) is also indistinguishable from *S. juruana* and is, thus, considered herein as its junior synonym.

Solaropsis peruviana has been described from Sahuayaco, Peru (800 m a.s.l.), circa 600 km southwest of HFR. As such, the geographic distribution of *S. juruana* is increased to encompass western Amazonas, Acre, and southeastern Peru.

Genetic data. Spm #1: CO1, MT080615; 16S, MT080823; ITS2+28S, MT080839; from voucher specimen UFAC 779 (Acre, Rio Branco, Bairro Universitário; E. Alencar leg., 9.VI.2017). Spm #2: CO1, MT080616; 16S, MT080813; ITS2+28S, MT080840; from voucher specimen UFAC 1091 (Acre, Rio Branco, Bairro Universitário, 09°56′51″S 067°53′11″W; G. Pedrosa leg., 14.VI.2019).

Type locality. Juruá River, Amazonas state, Brazil.

Distribution. Western Amazonas state, Brazil (Simone 2006).

Remarks. The present species is also classified in the genus *Psadara* Miller, 1878 in current literature (e.g., Simone 2006). A recent molecular analysis, however, has shown that *Psadara* is synonymous with *Solaropsis* (Calcutt et al. 2020).

Superfamily Helicoidea
Family Labyrinthidae

***Labyrinthus diminutus* Gude, 1903**
Fig. 6J–L

Labyrinthus Baeri var. *diminuta* Gude 1903: 262, pl. 7, figs. 1–4.

Material examined. Brazil • **Acre**, Porto Acre, HFR; 09°45′04″S, 067°40′07″W; 28.VIII.2018; M. Lima and W. Lima leg.; 1, MZSP 150037 (ex UFAC 921) • same locality; 09°45′23″S, 067°40′06″W; 12.X.2018; M. Lima and W. Lima leg.; 1, MZSP 150070 (ex UFAC 1003) • same locality; 09°45′12″S, 067°40′09″W; 23.IX.2018; M. Lima and W. Lima leg.; 1, MZSP 150074 (ex UFAC 969).

Identification. This species is identified by its comparatively small size, the somewhat flattened and step-like profile of the spire, and the low and convex sections of the body whorl above and below the median keel. The present record is the first actual report of the species from Acre, but it is a logical occurrence given that the species' distribution encompasses that state.

Genetic data. CO1, MT080612; 16S, MT080819; from voucher specimen UFAC 746 (Acre, Sena Madureira, Reserva Florestal do Antimary, 09°18'47.25"S 068°16'55.34"W; R. Portela leg., 14.III.2017; Fig. 6M–O).

Type locality. Perené, Peru.

Distribution. From central Peru to western Amazonas state, Brazil (Simone 2006).

Discussion

Twenty species were identified in the present study, of which 16 could be identified to the species level, with

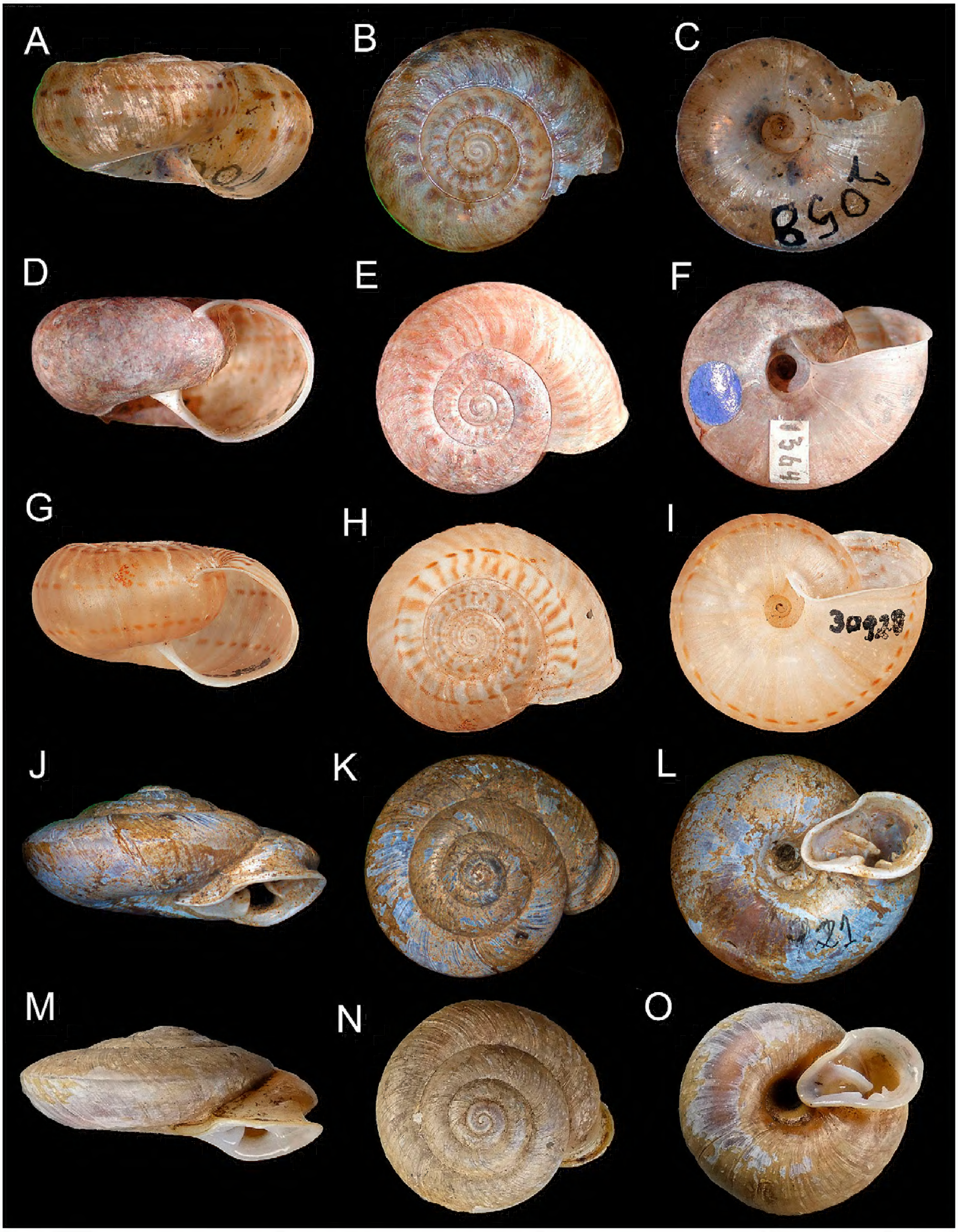

Figure 6. Shells from Acre state. **A–C.** *Solaropsis juruana*, MZSP 150069 (H = 18.7 mm). **D–F.** *Solaropsis juruana*, syntype MZSP 1364 (H = 20.0 mm). **G–I.** *Solaropsis peruviana*, holotype FMNH 30928 (H = 20.0 mm). **J–L.** *Labyrinthus diminutus*, MZSP 150037 (H = 22.3 mm). **M, N.** *Labyrinthus diminutus*, UFAC 746 (H = 12.7 mm).

the other four only to genus level. Given that the present study could not include analysis of leaf litter and soil samples, this number can be underestimating microgastropod species diversity (e.g., Pupilloidea, Punctoidea). Overall, 12 of the present species were recorded in Acre for the first time (Table 1), adding to the three *Helicina* spp. recently reported from that state (Salvador et al. 2020b).

Most of those newly recorded taxa (e.g., *Plekocheilus floccosus*) were expected to occur in Acre, given the

species' known distribution in the neighboring Amazonas and Rondônia states, but others represent a larger increase in geographic distribution. *Systrophia helicycloides*, in particular, was reported here for first time from Brazil. The remaining newly recorded species (*Beckianum beckianum*, *Leptinaria unilamellata*, and *Subulina octona*) are generalists, inhabiting a variety of habitats and being extremely widespread in the neotropics (Massemin et al. 2009; Birckolz et al. 2016; Silva et al. 2019). Finally, the synonymy of *Plekocheilus pentadinus* with *P. floccosus* is here reaffirmed, updating that species known distribution in Brazil, while *Solaropsis peruviana* is proposed here to be a junior synonym of *P. juruana*.

The present records provide important new insights into the taxonomic diversity of the otherwise critically undersampled state of Acre. In fact, this is the first systematic species inventory of mollusks focusing specifically on this state. Even so, it is important to note that HFR has suffered some degree of anthropogenic alteration (Collinge 1996), which likely means that the species assemblage reported here does not represent the full extent of diversity that is expected from other more pristine forested areas in Acre. Further collection efforts throughout the state will allow us to paint a more complete picture of gastropod diversity in Acre.

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Authors' contributions

MSL collected the specimens and drafted the first version of the manuscript; EG coordinated the fieldwork; FSS and LRLS led the taxonomic study; RBS revised the taxonomic study and obtained molecular data for the specimens; all authors contributed to the writing of the manuscript.

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